



Networking for Smart Spaces

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The Talk Ahead



- What's Changing?
- What's a Smart Space?
- Three Big Research Challenges
- *AirJava* - What? Why? How?
- Then What?

What's Changing?



- Mobile Work and Ad Hoc Teams



- Information Appliances



 - PDAs, Cell Phones, CrossPad, InfoPen ...

- Pico-Cellular Wireless



 - Bluetooth, HomeRF, IrDA ...

- Leading toward Smart Spaces?

What's a Smart Space?



- Wireless Island in Global Wired Ocean
- Available Information Services and Embedded Devices Discovered, Accessed, and Interconnected with
- Portable Devices Carried onto the Island
- Combination of Imported and Native Devices Exploited to Support Information Needs of Current Island Inhabitants

Challenge - Removing the Tyranny of an Interface Per Device



- Poly-Device, Poly-Modal (PDPM) Interfaces
 - Human-information interfaces distributed across devices and interaction modes
- What Might Be Needed?
 - Distributed Coordination Bus
 - Interaction Event Model
 - Mode-Specific Interaction Event Translators
 - Software Mechanisms for Dynamic Composition of Interfaces
 - Rules for creating effective PDPM interfaces for specific tasks and users, given available devices, services, and modalities

Challenge - Moving Information for People



■ Active Information

- Information objects that can communicate as a group to track the location, state, and trajectory of users, object replicas, and linked objects

■ What Might Be Needed?

- Secure processing infrastructure to support mobile code
- Scoping techniques for secure multicast communication
- Algorithms to plan the movement, replication, and transformation of information to serve projected needs of users
- Representations to specify, and mechanisms to implement, consistency, access, and sharing policies among replicated and linked information objects

Challenge - Adapting Information Delivery Using Knowledge of People, Places, and Things

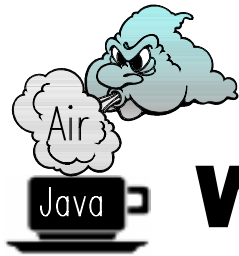


■ Inter-Space Models

- that cross the gap between physical and logical space as we perceive it and cyberspace as it exists in our computers and networks

■ What Might Be Needed?

- Techniques to automatically generate machine-processible models of physical spaces from video or still images
- Techniques to automatically generate machine-processible models of activities based on analysis of multiple sensory streams
- Languages to represent and reason about models of physical spaces, scenes, and logical activities



What? Why? How?

- Claim: Systems-on-a-chip (SOC) will cost \$10 within 5 years and will provide

- pico-cell wireless transceiver
- virtual machine
- run-time environment

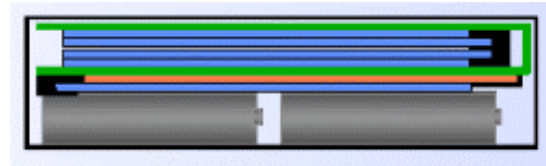
- *AirJava* adapter emulates tomorrow's SOC

- Low-power microcomputer and flash memory
- ISM wireless LAN PCMCIA Card
- Embedded or Personal Java Platform
- JavaOS and Jini

- *AirJava* adapter provides a platform for investigating the real challenges

- Poly-Device, Poly-Modal Interfaces
- Active Information
- Inter-Space Models ...

AirJava Adapter Design



- EPSON CARD 586
 - 133 MHz, 48 MB RAM, 256 KB ROM, 1 MB Video Memory
 - Bus Controller, XGA Controller, FDC, COMBO Controller
- 2 MB Flash Memory Card
- 320x240 Pixel Color LCD
- Proxim RangeLAN2 PCMCIA Type II
- Packing Approach from USC-ISI GUMPS Project

Then What?

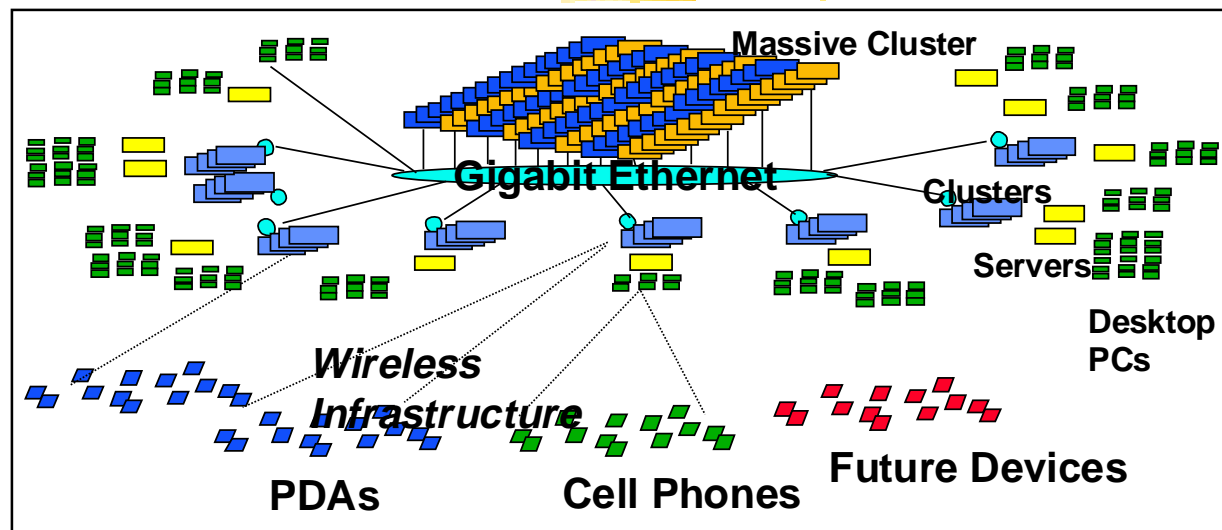
Explore the Design Space



- Can it work?
 - Can a pure Java solution work with tomorrow's systems-on-a-chip and pico-cellular wireless transceivers for multimedia information exchange? Delay? Throughput? Memory Consumption? Power Consumption?
- How should it work?
 - What information should a device reveal about itself?
 - How can previously unknown mobile code for device control be integrated into various target operating systems? Applets are obvious, but what about deeper forms of integration?

Then What?

Networking for Smart Spaces



Picture courtesy of
David Culler
UC Berkeley

- Integrate *AirJava*-adapted devices with wired networking infrastructure
- Exploit processing and bandwidth within the wired infrastructure to provide services for users through collections of mobile and embedded devices
- Exploit virtual private network technology to scope and protect communications and to manage information for ad hoc teams